THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI, TAMILNADU.

THE MODIFIED GAMMA NAIL FOR THE TREATMENT OF PERITROCHANTERIC FRACTURES

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INTRODUCTION

Intertrochanteric fractures are one of the most devastating injuries in the elderly. The incidence of these fractures increase with advancing age. These patients are more limited to home ambulation and are dependent in basic and instrumental activities of daily living. There is an association between patients developing intertrochanteric fracture and previous humeral, vertebral and distal radius fracture. Various modalities of fixation are available for the treatment of intertrochanteric fractures. The sliding hip screw device has been used for more than a decade for the treatment of these fractures. Though Zickel introduced his nail long ago it was not a very popular fixation device due to higher incidence of complications. So was the case with Enders nail. The Zickel nail was later modified and renewed interest is being given to intramedullary fixation with devices like the Gamma Nail, Intramedullary Hip Screw and the Proximal Femoral Nail due to shorter operating time, less blood loss and earlier mobilization for these devices. The Gamma Nail was independently developed by Halder, from the Royal Halifax Infirmary, England and Grosse at Strasburg, France. Initially the Gamma nail was used for the western population; modifications were later made to suit the Asian patients who had smaller proximal femora.

AIM OF THE STUDY

To assess the effectiveness of the Modified Gamma Nail for the treatment of peritrochanteric fractures

MECHANISMS OF INJURY

Intertrochanteric fractures in young adults are the results of high energy trauma like road traffic accidents or fall from height. In contrast 90 % of fractures occurring in the elderly are due to a simple fall. The tendency to fall increases with age and is exacerbated by several factors like poor vision, decreased blood pressure, poor reflexes, decrease muscle power, vascular disease and co existing musculoskeletal pathology.

Cummins and Nevitt identified four factors that determine whether a particular fall results in a fracture of the hip. a) The fall must be oriented that the person lands on or near the hip, b) inadequate protective reflexes that do not reduce the energy of fall, c) deficient local shock absorbers (muscle and bone around the hip) d) insufficient bone strength at the hip

Signs and Symptoms

Fractures may be undisplaced or impacted and, such patients may present with minimal pain at the hip, or may present with thigh pain. They may be ambulant. Whereas patients with displaced fractures are clearly symptomatic and usually cannot stand, much less ambulant.

Patients with undisplaced fracture may present with virtual absence of clinical deformity whereas those with displaced fracture exhibit the classic presentation of shortened and externally rotated extremity. There may be tenderness to palpation in the area of the greater trochanter. Ecchymoses may be present and should be noted.

RADIOGRAPHIC AND OTHER IMAGING STUDIES

Standard radiographic examination includes AP of the Pelvis and an AP and cross table lateral view of the proximal femur. The lateral radiograph can help to assess the posterior comminution of the proximal femur. An internal rotation view of the injured hip may be helpful to identify nondisplaced fractures. Internally rotating the involved femur 10 to 15 deg offsets the anteversion of the femoral neck and provides a true AP of the proximal femur .A second AP of the contra lateral side can be used for preoperative planning.

CLASSIFICATION

The commonly used classification is the Boyd and Griffin classification

Boyd and Griffin Classification (1949): his classification included all fractures from the extracapsular part of neck to a point 5 cm distal to the lesser trochanter.

Type 1: Fractures that extend along the Intertrochanteric line from the greater to the lesser trochanter. Reduction is usually simple and is maintained with little difficulty. Results are generally satisfactory.

Type 2: Comminuted fractures, the main fracture being along the Intertrochanteric line but with multiple fractures in the cortex. Reduction of these fracture are more difficult because the comminution can vary from slight to extreme. A particularly deceptive form of the fracture is one wherein there is an anteroposterior linear intertrochanteric fracture occurs as in type 1 but with an additional fracture in the coronal plane.

Type 3: Fractures that are basically subtrochanteric with at least 1 fracture passing across the proximal end of the shaft just distal to or at the lesser trochanter. Varying degrees of comminution are associated. These fractures are usually more difficult to reduce and result in more complications, both during operation and during convalescence.

Type 4 : Fractures of the trochanteric region and the proximal shaft, with fracture in at least 2 planes, one of which usually is the sagittal plane and maybe difficult to see in the routine anteroposterior roentgenograms. If open reduction and internal fixation are used 2 plane fixation is required because of the spiral, oblique or butterfly fracture of the shaft.

Evans devised a widely used classification system based on the division of fractures into stable and unstable groups. He divided the unstable fractures further into those in which stability could be restored by anatomical or near anatomical reduction and those in which anatomical reduction would not create stability. In Evans type 1 fracture, the fracture line extends upwards and outwards from the lesser trochanter, in type 2, the reverse obliquity fracture, the major fracture line extends outward and downward from the lesser trochanter. Type 2 fractures have a tendency towards medial displacement of the femoral shaft because of the pull of adductor muscles.

In Orthopaedic trauma association classification Group 1 fractures are simple 2 part fractures, group 2 fractures are comminuted with a posteromedial fragment, the lateral cortex of the greater trochanter however remains intact. Group 3 fractures are those in which the fracture line extends across both the medial and lateral cortices. This group includes the reverse obliquity pattern.

Unusual Fracture Patterns

Basicervical neck fractures are located just proximal to or along the intertrochanteric line. Though basicervical fractures are considered extracapsular, this may not always be the case. Basicervical fractures are thus at greater risk of osteonecrosis than the more distal intertrochanteric fractures. Furthermore basicervical fractures lack the cancellous interdigitation seen with fractures through the intertrochanteric region and are more likely to sustain rotation of the femoral head during implant insertion

Applied Anatomy

The intertrochanteric region of the hip consisting of the area between the greater and lesser trochanters represent a zone of transition from femoral neck to the femoral shaft. This area is characterized primarily by dense trabecular bone that serves to transmit and distribute stress similar to the cancellous bone of the femoral neck. The greater and lesser trochanters are the sites of insertion of the major muscles of the gluteal region, the gluteus medius and minimus, the iliopsoas and short external rotators. The Calcar femorale, a vertical wall of dense bone extending from the posteromedial aspect of the femoral shaft to the posterior portion of the femoral neck forms an internal trabecular strut within the inferior portion of the femoral neck and intertrochanteric region and act as a strong conduit for stress transfer.

The musculature of the hip region can be grouped according to function and location. The abductors of the gluteal region, gluteus medius and minimus which originate from the outer table of the ilium and insert on to the greater trochanter function to control pelvic tilt in the frontal plane. The gluteus medius and minimus along with tensor fascia latae are also the internal rotators of the hip. The hip flexors are located in the anterior aspect of the thigh and include the sartorius, pectineus, iliopsoas and rectus femoris, Iliopsoas inserts on the lesser trochanter .Gracilis and the adductor muscles(longus, brevis and magnus) are located in the medial aspect of the thigh. The short external rotators, the piriformis, obturator internus, obturator externus, superior and inferior gemelli and quadratus femoris all insert to the posterior aspect of the greater trochanter. The gluteus maximus originating form the ilium, sacrum and coccyx inserts onto the gluteal tuberosity along the linear aspera in the subtrochanteric region of the femur and the iliotibial tract.

Treatment options

Nonoperative treatment: Before the introduction of suitable fixation devices in the 1960s treatment for intertrochanteric fractures was of necessity nonoperative, consisting of prolonged bed rest in traction until fracture healing occurred (usually 10 to 12 weeks) followed by a lengthy programme of ambulatory training. In elderly patients this approach was associated with high complication rates. Typical problems included decubitus ulcer, urinary tract infection, joint contractures, pneumonia and thromboembolic complications. In addition fracture healing was accompanied by varus deformity and a shortened extremity because of the inability of traction in effectively counteracting the deforming muscular forces.

Indication of nonoperative treatment: 1) An elderly patient whose medical condition carries an excessively high risk of mortality from anaesthesia and surgery. 2) Non ambulatory patient who has minimal discomfort following fracture

Techniques of operative fixation have changed dramatically since the 1960s and the problems associated with early fixation devices have largely been overcome. Operative management consisting of fracture reduction and stabilization that permits early patient mobilization and minimizes many of the complications of prolonged bed rest, have consequently become the treatment of choice for intertrochanteric fractures.

Historically nonoperative management took one of the 2 different approaches. In first approach directed at early mobilization within the limits of patients discomfort the patient was allowed out of bed and in a chair within a few days of injury. Ambulation was delayed but the early bed to chair mobilization helped prevent many of the complications of prolonged recumbency. A second approach in contrast attempted to establish and maintain a reasonable reduction via skeletal traction .The period of traction using this technique was prolonged and an acceptable position was difficult to achieve and maintain. Nursing care was also exceedingly difficult and resulting in all the complications noted previously. When nonoperative management is required in the elderly usually the first approach is preferred.

OPERATIVE TREATMENT

Evolution of surgical techniques

Plate and screw devices: the first successful implants were fixed angle-nail plate devices, eg Jewett nail, Holt Nail consisting of a triflanged nail fixed to a plate at an angle of 130 to 150 degrees. While these devices provided stabilization of the femoral head and neck fragment to the femoral shaft, they did not affect fracture impaction. If significant impaction of the fracture site occurred the implant would either penetrate into the hip joint or cutout through the superior portion of the femoral head and neck. If on the other hand no impaction occurred lack of bony contact would result in either plate breakage or separation of the plate and screws from the femoral shaft. These experiences with fixed angle nail plate devices indicated the need for a device that would allow controlled fracture impaction. This gave rise to sliding nail plate devices, eg, Massi Nail, Kenn Pugh

Nail which consisted of a nail that provided proximal fragment fixation and a side plate that allow the nail to ‘telescope” within a barrel. Impaction provided bone on bone contact, which promoted fracture union.

The sliding nail plate devices gave rise to sliding hip screw devices. A blunt ended screw replaced the nail portion with a large outside thread diameter. Theoretically these alterations would result in improved proximal fragment fixation and decreased the risk of screw cut out by eliminating the sharp edges found on triflanged nails. To accomplish a bi-directional sliding the plate was modified by replacing the round screw holes with slotted screw holes (Eggers Plate). More recently a 2-component plate device was introduced, the Medoff plate in which a central vertical channel constraints an internal sliding component. The Alta expandable Dome plunger is a modified sliding hip screw designed to improve fixation of the proximal fragment by facilitating cement intrusion into the femoral head. Cement is kept away from the plate barrel so that the devices sliding potential is maintained

Intramedullary Devices

The various intramedullary devices that are being used for unstable intertrochanteric fractures are The Gamma Nail, The Intramedullary Hip Screw (IMHS) and The Proximal femoral Nail (PFN). These implants because of their intramedullary location are subjected to lesser bending moments than plate and screw devices.

Enders Nail was one of the earlier flexible intramedullary condylocephalic nails that were used for trochanteric fractures. But these implants were associated with higher rate of complications like rotational deformity, supracondylar femoral fracture, proximal migration of the pins through the femoral head, and back out of the nail with resulting knee pain and stiffness.

Cephalomedullary nailing with devices like the Gamma nail, the IMHS and the PFN offer several advantages, and these devices couple a sliding hip screw with a locked intramedullary nail. The device offers several advantages, a) an intramedullary nail because of its location theoretically provides more efficient load transfer compared to a sliding hip screw .b) the short lever arm of the intramedullary device can be expected to decrease the tensile strain on the implant, thereby decreasing the risk of implant failure, c) because intramedullary fixation device incorporates a sliding hip screw, the advantage of controlled fracture impaction is maintained.

Intramedullary nailing is a more technically demanding procedure. Short intramedullary devices that extend into the mid shaft of the femur are associated with stress fractures at the tip of the nail, an incidence of 3 to 6 % has been reported. Hence longer versions of these devices are being used that extend to the supracondylar region of the femur. The intramedullary nails have been shown to have a proven benefit in unstable inter trochanteric fractures.

The Gamma Nail is an effective intramedullary load-sharing device. It incorporates the principles and theoretical advantages of the Zickel nail, Dynamic hip screw and locked intramedullary nail (Bellabarba et al.. 2000). Biomechanically the Modified gamma nail is more stiff; it has a shorter moment arm (i.e., from the tip of the lag screw to the center of the femoral canal) whereas the DHS has a longer moment arm (i.e., from the tip of the lag screw to the lateral cortex). The DHS with a longer moment arm undergoes significant stress on weight bearing and hence higher incidence of lag screw cut out and varus malunion (Rosenblum et al..1992). The larger proximal diameter of the Gamma nail imparts additional stiffness to the nail (Rosenblum et al..1992*)*. Minimal blood loss, shorter operative time and early weight bearing are all the advantages of the Gamma nail whereas the DHS has a longer operating time, more blood loss (Leung et al..1992).

Reduction techniques

Until devices became available that allowed postoperative fracture impaction, one had to achieve fracture stability at surgery to minimize the risk of healing complications. In the absence of a stable medial buttress the incidence of implant failure and hip joint penetration was very high. Among the methods subsequently developed to restore medial cortical continuity are medial displacement osteotomy (Dimon Hughston Osteotomy), Valgus osteotomy (Sarmiento osteotomy), Lateral displacement osteotomy (Wayne County Osteotomy)

A medial displacement osteotomy alters the pathologic anatomy of the unstable fracture such that it is converted to a stable albeit non-anatomic position. The surgical technique includes a) transverse osteotomy of the proximal femoral shaft at the level of the lesser trochanter b) osteotomy and proximal displacement of the greater trochanter and its attached abductor musculature c) medial displacement of the femoral shaft d) impaction of the proximal fragment into the medullary canal of the shaft. Limb shortening can occur to the extent that the proximal femur is impacted to the femoral shaft. This can be at least partially counteracted by the valgus positioning of the proximal fragment, which in turn however may interfere with the function and position of the knee.

Sarmiento recommended a valgus osteotomy for unstable intertrochanteric fractures to provide medial cortical buttress. This technique involves a) An oblique osteotomy of the proximal femoral shaft, extending from the base of the greater trochanter to a medial position 1 cm distal to the apex of the fracture, b) implant placement into the proximal femoral fragment, 90 degree to the fracture surface c) reduction and impaction of the osteotomy surfaces.

Wayne and County described the lateral displacement osteotomy, which involves lateral displacement of the femoral shaft to create medial cortical overlap. This technique is used for those relatively unstable intertrochanteric fractures with a small posteromedial fragment.

Since the advent of sliding hip screws there has been a renewed interest in anatomic alignment. Hopkins et al reported on a series of 55 unstable intertrochanteric fractures treated with anatomic alignment or with medial displacement osteotomy and stabilized with sliding hip screws.89 % of he fractures that were anatomically aligned subsequently collapsed into a medially displaced position and 97 % of the same fractures united without any complication. The author concluded that the only advantage of medial displacement osteotomy was a slightly lower rate of trochanteric bursitis secondary to less fracture impaction and screw sliding.

Role of Tip Apex Distance

The authors demonstrated the utility of the TAD in a series of 198 intertrochanteric fractures; 16 fractures (8%) had loss of fixation secondary to lag screw cut-out occurred when the TAD was 27 mm or less, regardless of patient age, fracture stability, quality of fracture reduction, or type of angle of implant used. Conversely, the lag screw cut-out rate increased to 60% when the TAD was more than 45mm. Using multivariate logistic regression statistical techniques, the author demonstrated that screw position as measured by the TAD was the strongest (though but not the only) independent predictor of lag screw cut-out. (Unstable fractures and increasing patient age were also predictive of lag screw cutout.) It was thus recommended that if guide pin location yields a TAD of more than 25mm, the surgeon should reassess the fracture reduction and reposition the guide pin.

Unstable fractures

The most common unstable intertrochanteric fractures exhibit loss of the posteromedial buttress. Another type of unstable intertrochanteric fracture is the reverse obliquity pattern, which begins just proximal to the lesser trochanter and extends laterally follow a genera approach similar to that recommended for stable fracture patterns in the preceding section: anatomic fracture alignment followed by internal fixation using a sliding hip screw. In older patients, the posteromedial fragment is usually ignored. In younger patients, an attempt should be made to stabilize a large posteromedial fragment in a near-anatomic position to prevent excessive screw-barrel slide, which would result in limb shortening. Furthermore, axial loading studies of unstable fractures have confirmed that reduction and fixation of the posteromedial fragment becomes progressively more important with increasing fragment size.

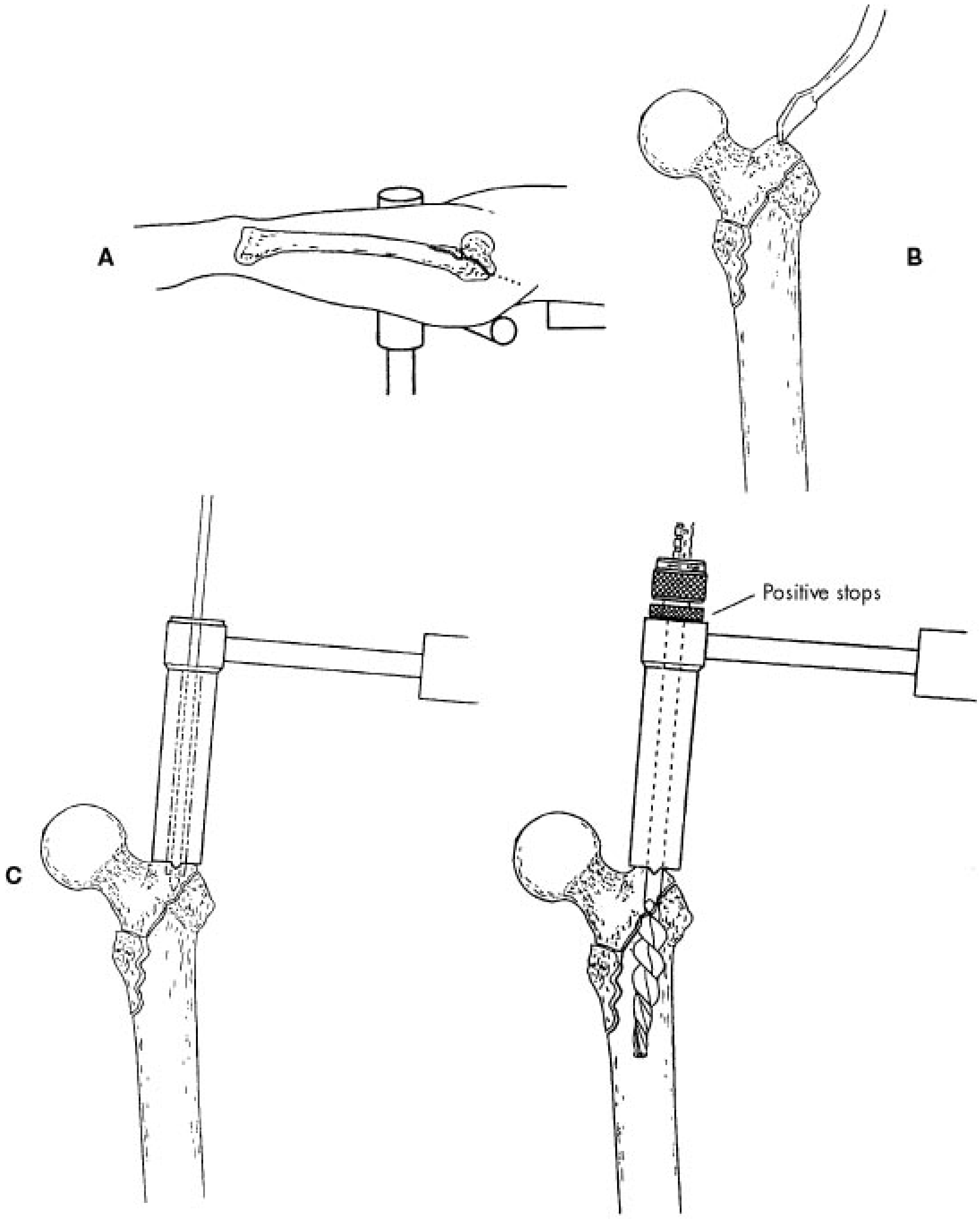
Reduction and stabilization of the posteromedial fragment can be performed either before or after application of the lag screw and side plate. The former method facilitates anatomic fracture reduction of the posteromedial fragment. If the main fracture fragments are reduced and stabilized first, it may be impossible to reduce the posteromedial fragment anatomically.

To mobilize and reduce the posteromedial fragment, there should be no traction on the lower extremity; since the iliopsoas is attached to the lesser trochanter, traction results in proximal migration of the posteromedial fragment. The extremity is externally rotated to better expose the posteromedial area of the femoral shaft. The posteromedial fragment can be reduced using a bone hook and provisionally stabilized using a Verbrugge or standard reduction clamp. Definitive fracture fixation involves use of either one or more cerclage wires or one or more lag screws directed from anterolateral to posteromedial. These screws cannot be inserted through the proximal hole of the plate, as proper angulation cannot be achieved because of the limitations of the screw hole

Once the posteromedial fragment is stabilized, traction is placed on the lower extremity and two main fragments reduced. The sliding hip screw is then inserted as previously described.

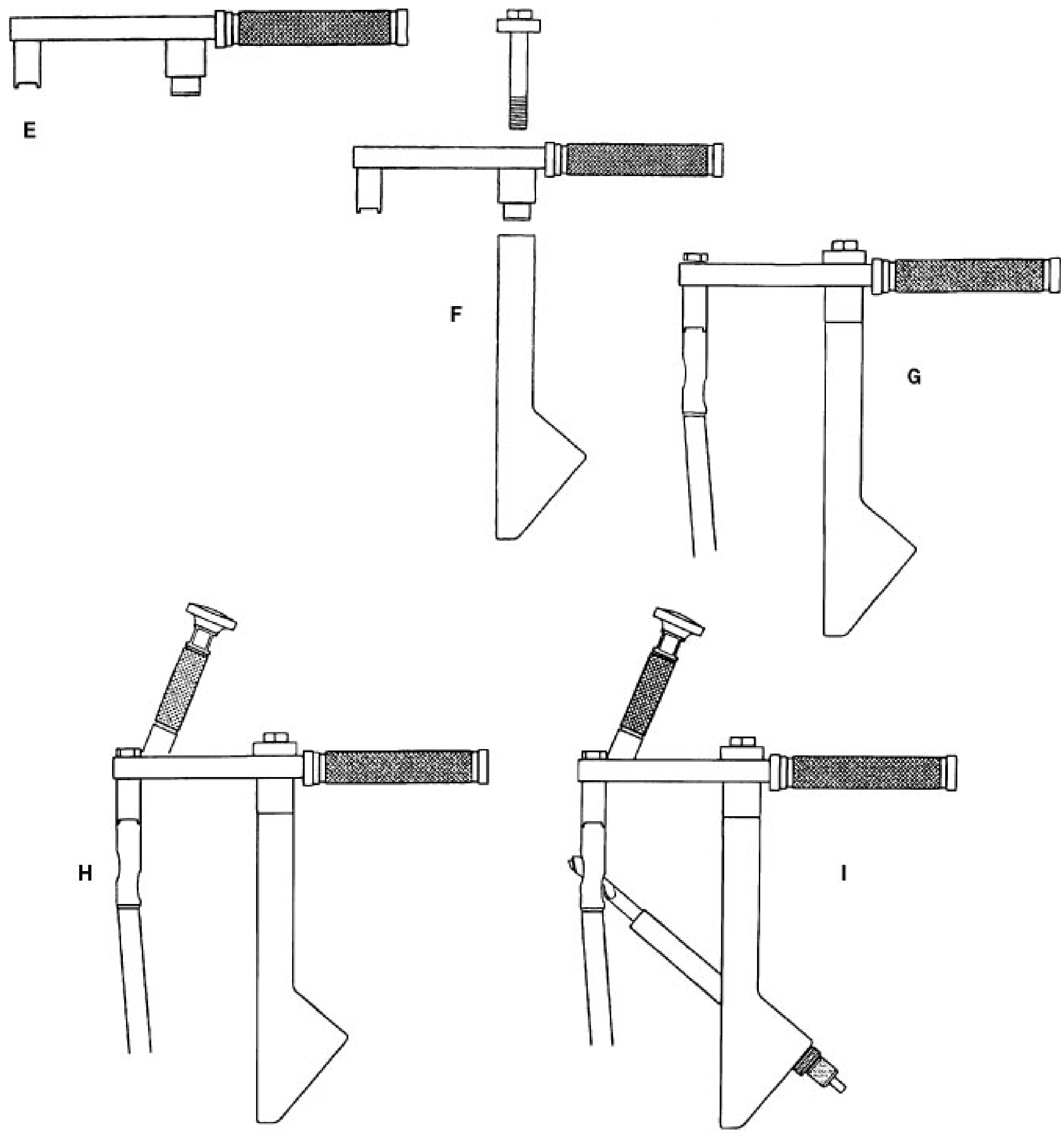
Modified Gamma nail

Evaluation of the appropriateness of an intramedullary device and estimation of nail diameter, lag screw angle, and length are performed using preoperative radiographs and templates. If there is a severe bowing of the affected femur or other associated deformity, use of an intramedullary device may be contraindicated. The patient is positioned supine on a fracture table, with both lower extremities resting in padded foot holders. The fracture is reduced as described with the use of a sliding hip screw, and the leg is placed in neutral or slight adduction to facilitate nail insertion through the greater trochanter; contra lateral leg is positioned so as to allow an unimpeded lateral radiograph. Since it is extremely difficult to insert an intramedullary nail with the hip abducted, abduction of the lower extremity is not used to correct the varus malreduction. Although it is possible to insert the intramedullary nail component of the device with the fracture unreduced and the leg adducted, followed by fracture reduction and lag screw insertion with the leg abducted, doing so can be very difficult technically. Therefore, if a varus reduction cannot be corrected without placement of the leg in abduction, it is preferable either to perform an open reduction with direct fracture exposure or to use a sliding hip screw for fracture stabilization .A lateral straight incision is made from tip of the greater trochanter extending proximally for 4 to 6 cm; the gluteus maximus muscle is dissected in line with its fibers. If an open reduction is required, one can extend the incision distally, incising the iliotibial band in the line with the skin incision. In this case, the vastus lateralis muscle is reflected anteriorly to expose the proximal femoral shaft. The entry point for an intramedullary hip screw is at the tip of the greater trochanter, halfway between its anterior and posterior extent. In younger individuals, particularly those with subtrochanteric fractures, it may be necessary to ream the femoral isthmus to accommodate the intramedullary nail; a ball tipped guide wire can be placed down the femoral shaft and a flexible cannulated reamer used to enlarge the proximal shaft to the appropriate diameter. In the elderly who have larger diameter medullary canals, this step is usually not necessary. The appropriately sized intramedullary nail is then assembled with its corresponding intramedullary angle guide attachment. It is imperative that the appropriate angle guide targets the proximal and distal holes in the nail using the drill sleeves and guide pin prior to device insertion. The nail is inserted by hand through the greater trochanter into the proximal femur. One should avoid use of excessive force, which may produce comminution of the proximal femoral shaft. It is also important that one use frequent fluoroscopic evaluation to follow the progression of the nail as it is inserted

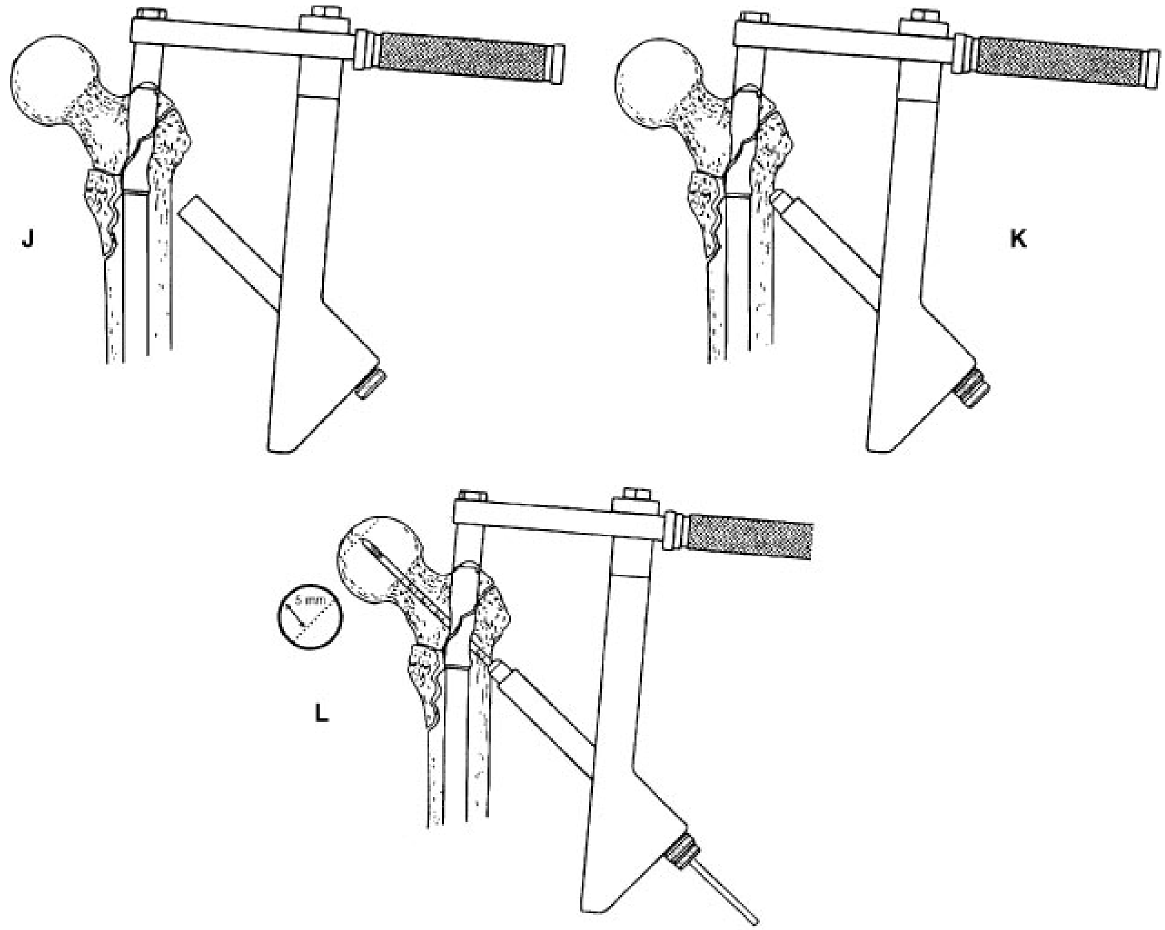


Technique for Modified Gamma Nail. **A,** Incision. **B** and **C,** Femoral preparation. **D,** Reaming through tissue protector

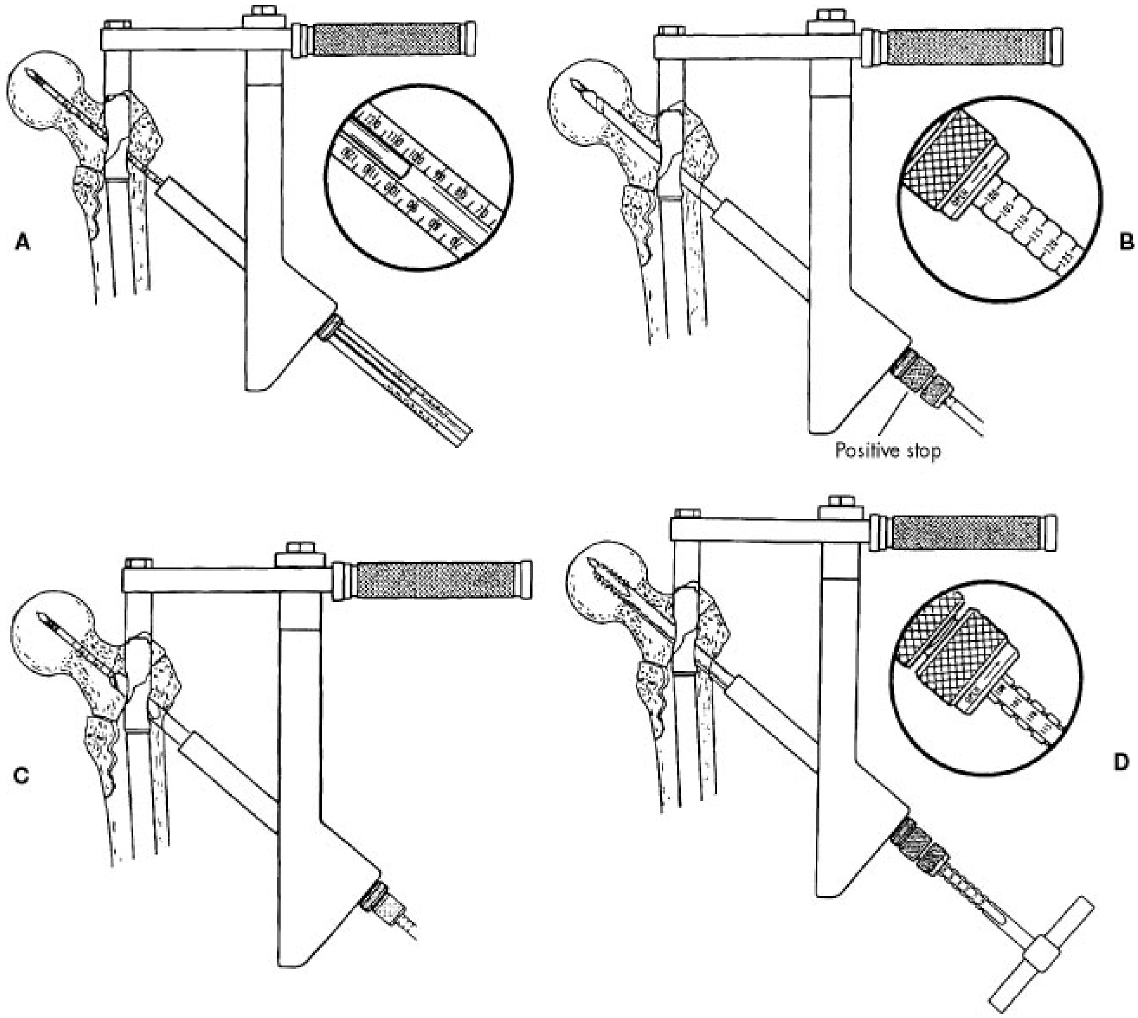
The nail is positioned to allow lag screw placement into the center of the femoral neck and head. The drill sleeves are inserted into the angle attachment and pushed to the lateral femoral cortex. It is important that the sleeves rest against bone and not the vastus lateralis muscle. The threaded guide pin is then inserted through the sleeves into the femoral neck and head using image intensification and advanced until it is 5 to 10 mm from the hip joint. As with the sliding hip screw, the guide pin should lie in the center of the femoral head and neck on both AP and lateral radiographic views. If the guide pin is not correctly positioned, it should be removed and the nail height and position confirmed.



E to **I,** Drill guide and nail assembly

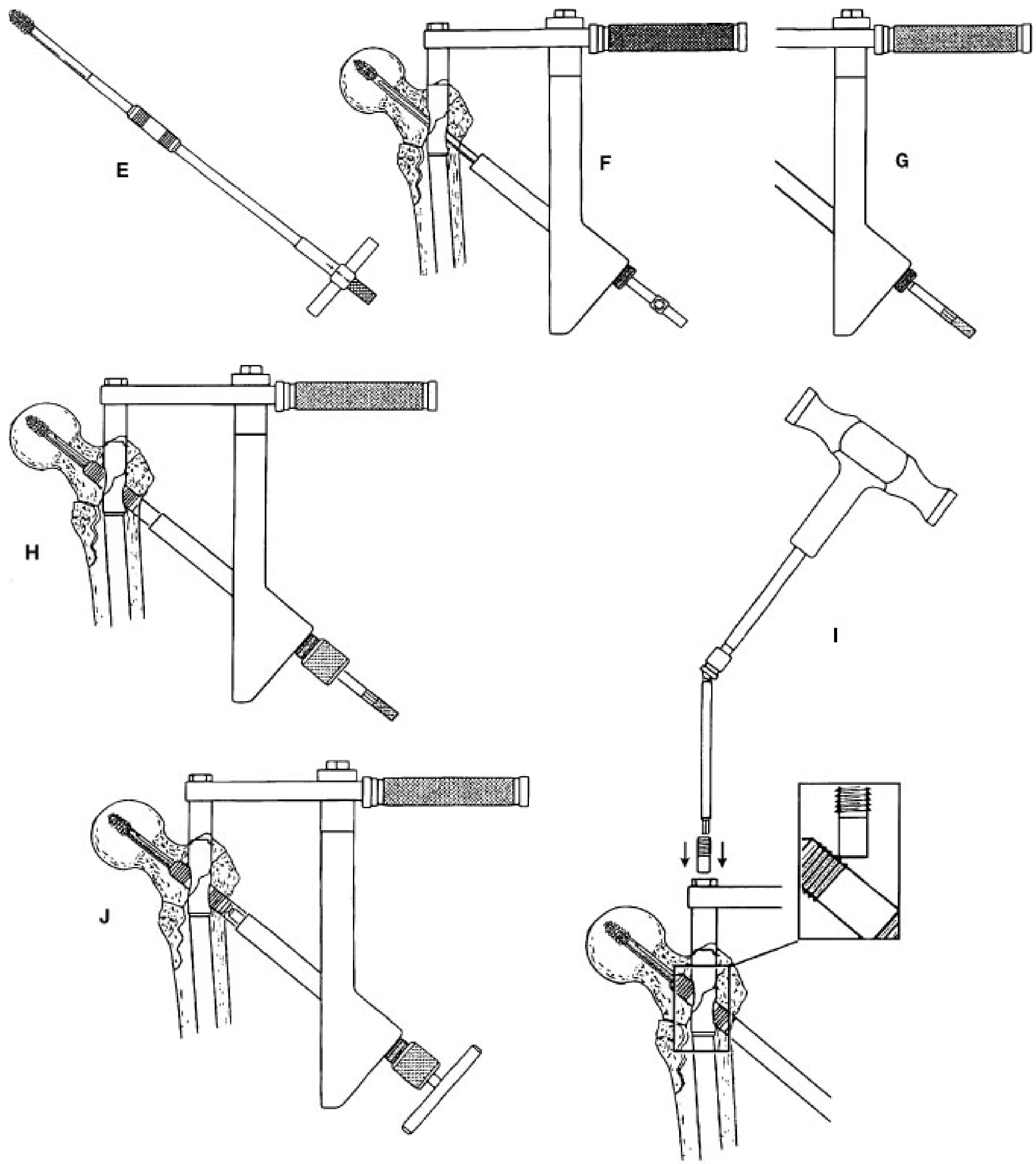


J to **L,** Proximal targeting and nail positioning



Technique for Modified gamma Nail.

A, Lag screw selection. **B** and **C,** Reaming for lag screw. **D,** Tapping for lag screw



E and **F,** Insertion of lag screw, sleeve, and set screw. **G,** Retaining rod attached to lag screw.**H,**Sleeve inserted tapped with slotted hammer until contact with silver drill sleeve is made. **I,** Insertion of set screw. **J,** Insertion of compression screw.

A cannulated reamer is advanced over the guide pin to the appropriate depth. The femoral neck and head are tapped and the lag screw inserted. In some systems, a centering sleeve is placed over the lag screw to position the lag screw within the intramedullary nail.

Distal targeting, is performed using the angle guide and drill sleeves. One must verify radiographically that the distal screws have passed through the nail

Basicervical Fractures

Since basicervical fractures-those located just proximal to or at the intertrochanteric line –are adjacent to the femoral neck region, some authors have advocated the use of multiple cancellous screws for fracture stabilization .The fracture pattern seen with a basicervical fracture, however, is more lateral than either the subcapital or transcervical fracture, thereby creating an increased varus moment at the fracture site. This, in turn, may result in toggling of multiple cancellous screws at their insertion points through the lateral cortex. The side plate of the sliding hip screw prevents screw toggling, theoretically reducing the risk of varus displacement. In addition, a sliding screw-plate device permits controlled fracture impaction.

When using a sliding hip screw for treatment of basicervical fracture, however, one must make a few modifications to the technique used for more distal intertrochanteric fractures. Because insertion of lag screw into the femoral head and neck may cause the proximal fragment to rotate, two guide pins are inserted, one in an inferior position and the second more superior. The sliding hip screw is placed over the inferior guide pin, while the proximal guide pin (or cannulated cancellous screw) helps to prevent rotation of the femoral head and neck segment .

Intertrochanteric Fractures with Subtrochanteric Extension

When they were first used, sliding hip screws were not recommended for fractures extending into the subtrochanteric region, but improvements in material properties and design have broadened the indications for these devices. Mullaji and Thomas, reporting on a series of 42 peritrochanteric and subtrochanteric fractures so treated, found that at an average follow-up of 11 months 91% of the surviving patients had united statisfactorily.

When treating an intertrochanteric fracture with subtrochanteric extension using a sliding hip screw, one should reduce and provisionally stablilize the subtrochanteric component, using lag screws or cerclage wire, prior to sliding hip screw insertion. This can be accomplished on the fracture table by releasing the traction and manipulating the extremity as needed. Once the subtrochanteric component has been reduced and stabilized, traction is reapplied and the position of the femoral head and neck component checked on both AP and lateral views. Placement of the sliding hip screw then proceeds as described above. Whenever possible, screws passed through the plate should be placed as lag screws to stabilize the subtrochanteric fracture component. The distal extension of the fracture necessitates a longer plate than with a pure intertrochanteric fracture with eight to ten cortices in the distal fracture fragment.

Comminution and Displacement of the Greater Trochanter

Because of the importance of the greater trochanter as the site of insertion for the abductor muscles, fractures that result in its comminution or displacement require special attention. If displaced, a tension-banding technique is used to reattach the greater trochanter and preserve or restore abductor tendon and passed around the plate barrel. With the plate stabilized to the femoral shaft, the cerclage wire is tightened to provide secure reattachment

Prosthetic Replacement

Primary prosthetic replacement has had limited use in a acute intertrochanteric fracture management. Successfully treated by internal fixation. However, some elderly patients who sustain a comminuted unstable intertrochanteric fracture experience loss of reduction of fixation and require revision surgery. This population of patients would benefit most from primary prosthetic replacement. However, it is virtually impossible to identify these patients prior to surgery.

The only indications for primary prosthetic replacement after intertrochanteric fracture considered by us are (a) symptomatic ipsi-lateral degenerative hip disease (total hip replacement), and (b) attempted open reduction and internal fixation (ORIF) that cannot be performed because of extensive comminution and poor bone quality.

Composite Fixation

Introduced by Harrington as a means of enhancing internal fixation, use of adjunctive methylmethacrylate ("bone cement") has been advocated in patients with severe osteopenia who have sustained a comminuted, unstable intertrochanteric. Muhr et al. emphasized that the purpose of the cement is to maintain stability of the fracture- implant construct until osseous union occurs; these authors, who treated 231 intertrochanteric fractures with cement augmentation, argued that the cement provides the stability necessary for immediate weight bearing after surgery.

Reporting on a series of 38 unstable intertrochanteric fractures whose treatment included cement augmentation, Cheng et al. found that 76% had a good or excellent result at an average follow-up 3.7 years. Late complications occurred in six patients and included non-union, screw protrusion, partial destruction of the femoral head, subcapital fracture head. All complications occurred at least 1 year after surgery and were attributed to inappropriate placement and /or excessive amounts of cement resulting in inadequate new bone formation.

Methylmethacrylate can be used to enhance lag screw fixation within the femoral head or fixation of the plate-holding screws, depending on the area of compromised fixation. When employing this technique, it is essential to obtain good fracture impaction at surgery.

Soft tissues and cement intrusion into the fracture site, which could interfere with healing .The technique for methylmethacrylate enhancement of the lag screw and plate-holding screws is similar and involves screw insertion followed by screw removal, injection of liquid methylmethacrylate by syringe into the empty screw hole, and screw reinsertion. Precooling the cement monomer gives the surgeon more time for the procedure. It is interesting to note that if the screw is turned as the methylmethacrylate hardens and the screw track is then drilled and tapped, its holding power is also diminished. Therefore, the screw should be fully placed in the cement while it is still soft and tightened after the cement has set.

Pathologic Fractures

Operative treatment is indicated for most pathologic intertrochanteric fractures. This treatment approach maximizes patient function, alleviates pain, facilitates nursing care, decreases the duration and cost of hospitalization, and improves morale.

Composite fixation, consisting of a sliding hip screw supplemented with methylmethacrylate to fill the voids left by removal of macroscopic tumor; (b) locked intramedullary nailing; and (c) proximal femoral replacement. Composite fixation with a sliding hip screw has been described by Walling and Bahner.

Proximal femoral replacement can be used for those lesions that are too extensive for composite fixation. The main disadvantage of proximal femoral replacement is the mandatory need for reattachment of the hip abductors. Proximal femoral replacement with a long-stem component has the advantage, however, of providing prophylactic fixation of more distal femoral shaft lesions.

Polytrauma Patients

Polytrauma patients (typically young adults who have experienced high-energy trauma) should undergo immediate stabilization of all long-bone fractures.

Ipsilateral intertrochanteric- femoral shaft fractures occur less frequently than do concomitant femoral neck- shaft fractures. If the hip and shaft fractures are in close proximity, a sliding hip screw with a long side plate may suffice; this is by far the simplest and most effective means of stabilizing the two adjacent fractures. One attractive treatment option is to stabilize the intertrochanteric fracture with a sliding hip screw and the femoral shaft fracture with an interlocked retrograde nail. If the femoral shaft fracture is transverse and not comminuted, retrograde inserted Ender nails can be used for femoral-shaft fixation in conjunction with a sliding hip screw. It is possible to use a cephalomedullary nail with screws anchored in the femoral head and neck, but results are poorer for stabilization of ipsilateral intertrochanteric-femoral shaft fractures than for ipsilateral femoral neck-shaft fractures.

POSTOPERATIVE FRACTURE CARE

The mobilization of hip fracture patients out of bed begin and ambulation training be initiated on postoperative day. 1. Furthermore, any patient who has been surgically treated for an intertrochanteric fracture should be allowed to bear weight as tolerated.

Restricted weight bearing after hip fracture has little biomechanical justification, since activities such as moving around in bed and use of a bedpan generate forces across the hip approaching those resulting from unsupported ambulation. Even foot and ankle range-of-motion-motion exercises performed in bed produce substantial loads on the femoral head secondary to muscle contraction.

Several studies have demonstrated that unrestricted weight bearing does not increase complication rates following fixation of intertrochanteric fractures.

COMPLICATIONS

Loss of Fixation

Fixation failure with either a sliding hip screw or an intramedullary hip screw is most commonly characterized by varus collapse of the proximal fragment with cut –out of the lag screw from the femoral head. The incidence of fixation failure is reported to be as high as 20% in unstable fracture patterns. Lag screw cutout from the femoral head generally occurs within 3 months of surgery and is usually due to (a) eccentric placement of the lag screw within the femoral head (b) improper reaming that creates a second channel; (c) inability to obtain a stable reduction; (d) excessive fracture collapse such that the sliding capacity of the device is exceeded; (e) inadequate screw-barrel engagement, which prevents sliding; or (f) severe osteopenia, which precludes secure fixation.

Achieving a stable reduction with proper insertion of the sliding hip screw is the best way of preventing postoperative loss of fixation. Rarely, fixation failure results from loss of fixation of the plate –holding screws.

When fixation failure occurs, management choices include (a) acceptance of the deformity; (b) revision ORIF, which may require methylmethacrylate; (c) conversion to prosthetic replacement. Acceptance of the deformity should be considered in marginal ambulators who are a poor surgical risk. Revision ORIF is indicated in younger patients, while conversion to prosthetic replacement (unipolar, bipolar, or total hip replacement) is a preferred in the elderly patient with osteopenic bone.

Nonunion

Nonunion following surgical treatment of intertrochanteric fracture occurs in less than 2%of patients; its rate occurrence is largely due to the fact that the fracture occurs through well-vascularized cancellous bone. The incidence of nonunion is highest in unstable fracture patters. Mariani and Rand et al..1987 reported on 20 nonunions, 19 of which (95%) occurred in fracture with loss of posteromedial support. Most intertrochanteric nonunions follow unsuccessful operative stabilization, with subsequent varus collapse screw cutout through the femoral head. Another possible etiology for intertrochanteric nonunion is an osseous gap secondary to inadequate fracture impaction. This can occur as a result of “jamming” of the lag screw within the plate barrel or mismatch of the lag screw and plate barrel length leading to the loss of available screw barrel slide. Both barrels can be avoided with proper attention to the details of device insertion.

Intertrochanteric nonunion should be suspected in patients with persistent hip pain that have radiographs revealing a persistent radiolucency at the fracture site 4 to 7 months after fracture fixation. Progressive loss of alignment strongly suggests nonunion, although union may occur after an initial change in alignment, particularly if fragment contact is improves. Abundant callus formation may be present, making the diagnosis of nonunion difficult to confirm. Tomography evaluation may help to confirm the diagnosis; otherwise the diagnosis may not be possible until the time of surgical exploration .As with any nonunion, the possibility of an occult infection must be considered and excluded. In some cases, with good bone stock, repeat internal fixation combined with a valgus osteotomy and bone grafting can be considered however, in most elderly individuals, conversion to a Calcar replacement prosthesis is preferred.

Malrotation Deformity

The usual cause of malrotation deformity after intertrochanteric fracture fixation is internal rotation of the distal fragment at surgery. In unstable fracture patterns, the proximal and distal fragments may move independently; in such cases, the distal fragment should be placed in neutral to slight external rotation during fixation of the plate to the shaft. When malrotation is severe and interferes with ambulation, revision surgery with plate removal and rotational osteotomy of the femoral shaft should be considered.

Other complications

Osteonecrosis of the femoral head is rare following intertrochanteric fracture. No association has been established between location of the implant within the femoral head and the development of osteonecrosis, although one should avoid the posterior superior aspect of the femoral head because of the proximity of the lateral epiphyseal artery system.

Various case reports have documented unusual complications relating to lag screw-side plate separation and lag screw migration the pelvis. Lag screw – side plate separation can be prevented by using a compression screw if there appears to be inadequate screw-barrel engagement. Most cases of lag screw migration into the pelvis occur in unstable fractures and are associated with improper reaming and violation of the hip joint or the presence of inadequate screw-barrel engagement.

Laceration of the superficial femoral artery by a displaced lesser trochanter fragment has been reported as well as binding of the guide pin within the reamer, resulting in guide pin advancement and subsequent intraarticular or intrapelvic penetration.

MATERIALS AND METHODS

At our institution we selected 18 cases of peritrochanteric fractures for this prospective study. All 18 cases were treated with the Modified Gamma nail (indigenous) of which 17 patients came for regular follow up and they were included in the study. The age group varied from a minimum of 35yrs to a maximum of 72 years, and average age was 54 years. The duration of the study was from June 2003 to May 2005. The mean follow up was 1and half years. Of the 17 patients 11 were males and 6 were females. Right side was involved in 9 cases and in 8 patients the left side was involved.12 patients were sedentary workers and 5 patients were manual labourers.

All the fractures were classified according to the Boyd and Griffin classification for peritrochanteric fractures.

12 patients were classified as type 2,

2 cases were type 3, and

3 cases were type 4.

All of them were unstable peritrochanteric fractures.

Mode of Injury

Accidental fall was the most common mode of injury : 14 cases

Road traffic accidents : 3 cases.

Associated injuries

Tibial pilon fracture	–	1 case (opposite leg)
Fracture of both bones of forearm	–	1 case
Fracture of shaft of humerus	–	1 case

The average interval from injury to the time of surgery was 5 days. All the patients were managed initially with skeletal traction before taking up for surgery. The patient with tibial pilon fracture was treated conservatively. Patients with fracture of both bones of forearm and patient with fracture shaft of humerus were treated by Open reduction and internal fixation after internal fixation of the trochanteric fracture.

Preoperative Planning

Preoperative templating with AP roentgenogram of the injured hip was used to measure the nail diameter and the lag screw length.

Implants and Instrumentation

The Modified Gamma Nail is an Indian made version of the original Asia Pacific (AP) Gamma Nail, which had a proximal diameter of 17mm.The proximal diameter of Modified Gamma Nail, is 15 mm to suit the proximal femora of Indian patients.

Length of Modified Gamma Nail	–	180mm
Distal diameters	–	9, 10, 11mm
Lag screw diameter	–	10mm
Lag screw lengths	–	75, 80, 85, 90, 95, 100 mm
135 degree angled		
Distal locking bolts	–	4.9mm diameter

Setscrew to control rotation

Top screw (cap): to prevent bone growth into the nail

Jig with proximal and distal locking holes

Guide wire: 2×450mm

Cannulated proximal and distal reamers

Guide wire sleeve and drill sleeves

Anaesthesia, positioning and use of image intensifier

The surgery was done in a standard radiolucent fracture table in supine position with the use of image intensifier. Spinal anaesthesia was used in 14 patients and 3 patients were operated under general anaesthesia.

Surgical technique

All the fractures were treated with initial closed reduction with alignment of the medial cortex. In one patient we could not achieve closed reduction because of soft tissue interposition in which case open reduction was resorted to.

Incision

The approach for the Modified Gamma nail is a 5 cm incision extending proximally from the greater trochanter followed by careful separation of the abductors.

Entry Point

The point of entry is the tip of the greater trochanter at the junction of anterior $1/3^{rd}$ and posterior $2/3^{rd}$ of the greater trochanter with a curved awl.

Guide wire insertion and reaming

The guide wire is inserted using a tissue protector and a guide pin-centering sleeve well beyond the subtrochanteric region. The position of guide pin is checked in AP and lateral views. The 15 mm Cannulated proximal femoral reamer is used to ream the proximal femur for upto 7 cm. Distal reaming of the canal is done with graded cannulated reamers.

Nail Insertion and Proximal targeting

The nail is inserted with the help of the jig over the guide wire; flourosopic images are taken when the nail is being introduced to check for any peroperative femoral fractures. The nail along with the jig is inserted by hand by gentle twisting movements and rarely hammered. Once the nail is positioned appropriately, the guide wire is removed and drill sleeves are attached to the jig and through a stab incision over the lateral thigh the drill sleeve is pushed upto the lateral cortex .The guide pin is then passed into the head and neck using the guidepin sleeve. The guidepin is advanced to 5mm from the articular surface of the femoral head. Proximal locking is done with lag screws of various lengths as measured preoperatively with templates and intraoperative measurement.

A setscrew is inserted into the proximal end of the nail after nail and lag screw positioning to prevent any rotation at the nail-lag screw interface. It is followed by application of a cap (top screw) to prevent bone growth should the nail had to be removed later.

Distal targeting

Distal locking also is done with the aid of the jig and 2 distal locking screws.

The operating time was calculated from the start of surgical incision to wound closure. In the initial cases our operating time was on the higher range. With experience the operating time reduced. Operating time varied from 54 to 82 minutes. The blood loss was calculated from the number of surgical mops that were used, each corresponding to 50ml of blood. Blood loss varied from 100 to 150ml. The average blood loss was 122ml in those treated with the Modified Gamma nail. The duration of image intensifier in patients treated with the modified gamma nail was calculated in seconds.

Complications were encountered intraoperatively like breakage of screw head of distal locking bolts in 2 patients, which were left alone. One technical error was encountered where the lag screw was placed in the superior quadrant of the femoral head, which was removed immediately and reapplied, in the inferior quadrant.

Postoperative Protocol

Patients were mobilized with physiotherapy on the first postoperative day. Patients were allowed partial weight bearing with aids as tolerated. Sutures were removed on the 12th postoperative day. The time for fracture healing was evaluated according to radiographic and clinical criteria. Clinically union was observed as the absence of tenderness or pain with full weight bearing**.** Patients were evaluated clinically and radiologically at 3 weeks for the first 3 months and thereafter monthly for the next 3 months and bimonthly for the next 12 months. During follow up the Harris Hip score was evaluated at 3 months and 6 months postoperatively. Various parameters like Pain, Limp, use of Support, Distance walked, Stair climbing, Sitting, Absence of deformity, Range of motion were evaluated using the Harris Hip score.

RESULTS

	Modified Gamma Nail
Operating time	70.4mins
Blood loss	122ml
Abductor lurch	3 cases
Varus deformity	1
Superior cut out of lag screw	Nil
Fracture union	13 weeks
Image intensifier	118 seconds
Harris hip score at 6 months	85

Average operating time was 70.4 minutes for the patients treated with the Modified Gamma Nail. Blood loss varied from 100 to 150ml. The average blood loss was 122ml in those treated with the Modified Gamma nail. The mean usage of image intensifier was 118 seconds**.** Fourteen fractures healed at an average of 12 weeks postoperatively (range 9-19 weeks) of the index procedure. All the patients were ambulated early as early as 3 weeks with aids and at the end of 6 weeks all patients were allowed full weight bearing. The mean Harris Hip score at the end of 3 months was 79 and at the end of 6 months was 85. 1 patient required a cane during subsequent follow up. All the patients went back to their original work**.** None of the patients developed thigh pain**.**

No lag screw cut out was present in the patients treated with the Modified Gamma nail. Three patients treated with the Modified Gamma nail developed abductor lurch. . One patient developed varus deformity of 12^0 Superficial wound infection occurred in 2 patients treated with Modified gamma Nail which settled down with antibiotics. There was no case of deep infection.

DISCUSSION

The Modified Gamma Nail is an effective intramedullary load-sharing device. It incorporates the principles and theoretical advantages of the Zickel nail, Dynamic hip screw and locked intramedullary nail (Bellabarba et al.. 2000). Biomechanically the Modified gamma nail is more stiff; it has a shorter moment arm (i.e., from the tip of the lag screw to the center of the femoral canal) whereas the DHS has a longer moment arm (i.e., from the tip of the lag screw to the lateral cortex). The DHS with a longer moment arm undergoes significant stress on weight bearing and hence higher incidence of lag screw cut out and varus malunion (Rosenblum et al..1992). The larger proximal diameter (15mm) of the modified Gamma nail imparts additional stiffness to the nail (Rosenblum et al..1992). Minimal blood loss, shorter operative time and early weight bearing are all the advantages of the Gamma nail whereas the DHS has a longer operating time, more blood loss (Leung et al..1992).

In the current study the union rate was 100% with one case of varus malunion. There were no cases of preoperative and postoperative femoral fractures

The average blood loss in patients treated with the Gamma nail was 122ml.The results were comparable with Bellabarba et al.,2000, Radford, Needoff et al..1993.

	Bellabarba et al 2000	**Radford et al 1993**	**Our series**
Average blood loss	104ml	120 ml	122ml

Average operating time in our series was 70.4 minutes.

In our initial cases operating time was on the higher range (Range 54-82 min).With experience the operating time reduced

Results were comparable to the series of Leung et al..1992, Chen et al..1993, Bellabarba et al..2000

	Leung et al 1992	**Chen et al 1993**	**Bellabarba et al 2000**	**Our series**
Average operating time	42.9 min	58min	53 min	70.4min

The use of image intensifier was 118 seconds in patients treated with the Modified Gamma Nail, which is considerably less than that of Halder's series (5.4 minutes in Halder et al..1992 series)

In comparison, mechanical failure of DHS occurs in 10 to 20 % of cases primarily due to cutting out of the lag screw superiorly (Wolfgang, Bryant and O'Neill et al..1982). The operative blood loss in patients treated with DHS is higher (250 ml in Radford et al.. 1993 series).Full weight bearing is delayed in patients treated with DHS(Leung et al..1992).

Despite the short lever arm screw cut outs have been reported in patients treated with the Gamma nail (Bridle, Patel, Bircher, Calvert et al. 1991). The primary cause of this is related to positioning of lag screw within the femoral head. To prevent this complication the lag screw should be placed in the femoral head within 5 to 10 mm of subchondral bone (Bellabarba et al. 2000) centrally. We have followed this and we have not encountered any lag screw cut out in our patients.

Peroperative and postoperative femoral fractures have been documented in patients treated with the gamma Nail (Leung et al. 1992). Multiple factors have been implicated like implant design and operative technique. Decreases in implant curvature, diameter, over reaming of femoral canal by 1.5 to 2mm, insertion of the implant by hand and meticulous placement of the distal locking screws without creating additional stress risers decreases the complication rate of femoral shaft fracture (Bellabarba et al.. 2000).Patients with narrow femoral canal and abnormal curvature of the proximal femur are relative contra indications to Gamma Nailing

(Halder et al..1992). We have followed these recommendations in our series. Hence in our series we have not encountered any peroperative and postoperative femoral shaft fractures. A larger cohort of patients is necessary to document the incidence of peroperative and postoperative femoral shaft fractures, which is a limitation of our study.

In our series the incidence of abductor lurch in the post operative period was 17.5%. Gluteus medius tendon injury has been reported in 27% patients with the use of Gamma nail (Mc Connell et al 2003). The abductor lurch may improve in many numbers of patients and may remain static in some patients. Since the follow-up period of this study is short which is a limitation of our study, we could not definitely quantify the number of patients who developed permanent damage to abductor musculature.

In short, the Modified Gamma Nail is a better implant with distinct advantages over the DHS. With adequate surgical technique, the advantages of the Gamma Nail increases and the complication rate decreases (Valverde et al.1998)

CONCLUSION

Intramedullary nailing with the Modified Gamma Nail has distinct advantages over DHS like shorter operating time and lesser blood loss for unstable Peritrochanteric fractures.

Modified Gamma Nail**-** by decreasing the proximal diameter of the original Gamma Nail (15mm), is a suitable alternative for DHS in Indian patients

Early mobilization and weight bearing is allowed in patients treated with Modified Gamma nailing thereby decreasing the incidence of bedsores, Uraemia and hypostatic pneumonia.

The incidence of peroperative and postoperative femoral shaft fractures in Modified Gamma nailing can be reduced by good preoperative planning and correct technique, adequate reaming of the femoral canal, insertion of implant by hand and meticulous placement of distal locking screws

Modified Gamma nailing is a significant advancement in the treatment of Peritrochanteric fractures which has the unique advantage of closed reduction, preservation of fracture hematoma, less tissue damage during surgery, early rehabilitation and early return to work.

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PROFORMA

NAME : AGE: SEX:

ADDRESS :

IP No: Unit: DOA: DOS: DOS: WARD:

Mode of Injury : Side of Injury: R/L

Associated Injuries : Head / Abdomen / Pelvis / other limb injuries

Boyd and Griffin Classification

Investigation

- Plain X-Ray Pelvis AP and Lateral views
- Urine albumin / sugar
- Blood Hb / BT / CT / Urea / Sugar / Grouping and typing
- Chest X-Ray
- ECG

Initial Management :

Improvement of General Condition

Closed reduction / Upper tibial pin traction/Bohler Braun splint

Details of other treatment particulars

SURGERY

- Interval between injury and surgery
- Patient positioning
- Operating time
- Entry Portal
- Method of fracture reduction
- Type of implant
- Length and diameter of nail
- Length of lagscrew
- Details proximal and distal locking
- Amount of blood loss / blood transfusion
- Fluoroscopic exposure (in seconds)

Complications

Improper placement of nail splitting of entry site

Varus positioning

Peroperative femoral shaft fractures

Failure of distal locking

Early Postoperative – Infection

Abductor lurch

CLINICAL AND RADIOLOGICAL ASSESSMENT DURING FOLLOW UP PERIOD

Fracture union at – weeks

Harris hip score - 3 months
- 6 months

Age

Age group	Modified Gamma	
	No	%
≤ 40	2	11.8
41 - 50	5	29.3
51 - 60	6	35.3
61 - 70	3	17.7
> 70	1	5.9
Total	17	100
Mean	54.1	
S.D	10.6	

Sex

Sex	Modified Gamma Nail	
	No	**%**
Male	11	64.7
Female	6	35.3

Mode of Injury

Mode of injury	Modified Gamma Nail	
	No	%
Accidental fall	14	82.4
RTA	3	17.6

Classification

Classification (Boyd and Griffin)	Modified Gamma Nail	
	No.	%
I	-	-
II	12	70.6
III	2	11.8
IV	3	17.6

Interval between injury and surgery

Interval (days)	Modified Gamma Nail	
	No	%
< 2	-	-
2	1	5.9
3	3	17.6
4	4	23.5
5	2	11.8
6	3	17.6
7	3	17.6
8	1	5.9
> 8	-	-
Total	17	100
Mean	4.94	
S.D	1.75	

Operating time

Operating time (min)	Nail MG Group	
	No	%
≤ 60 min	3	17.6
61 - 75	8	47.1
76 - 90	6	35.3
91 - 105	-	-
> 105	-	-
Mean	70.41	
S.D	9.19	

Blood loss

Blood loss (ml)	Nail MG Group	
	No	%
$\leq$ 100	6	35.3
101 – 150	11	64.7
151 – 200	-	-
> 200	-	-
Mean	122.06	
S.D	19.53	

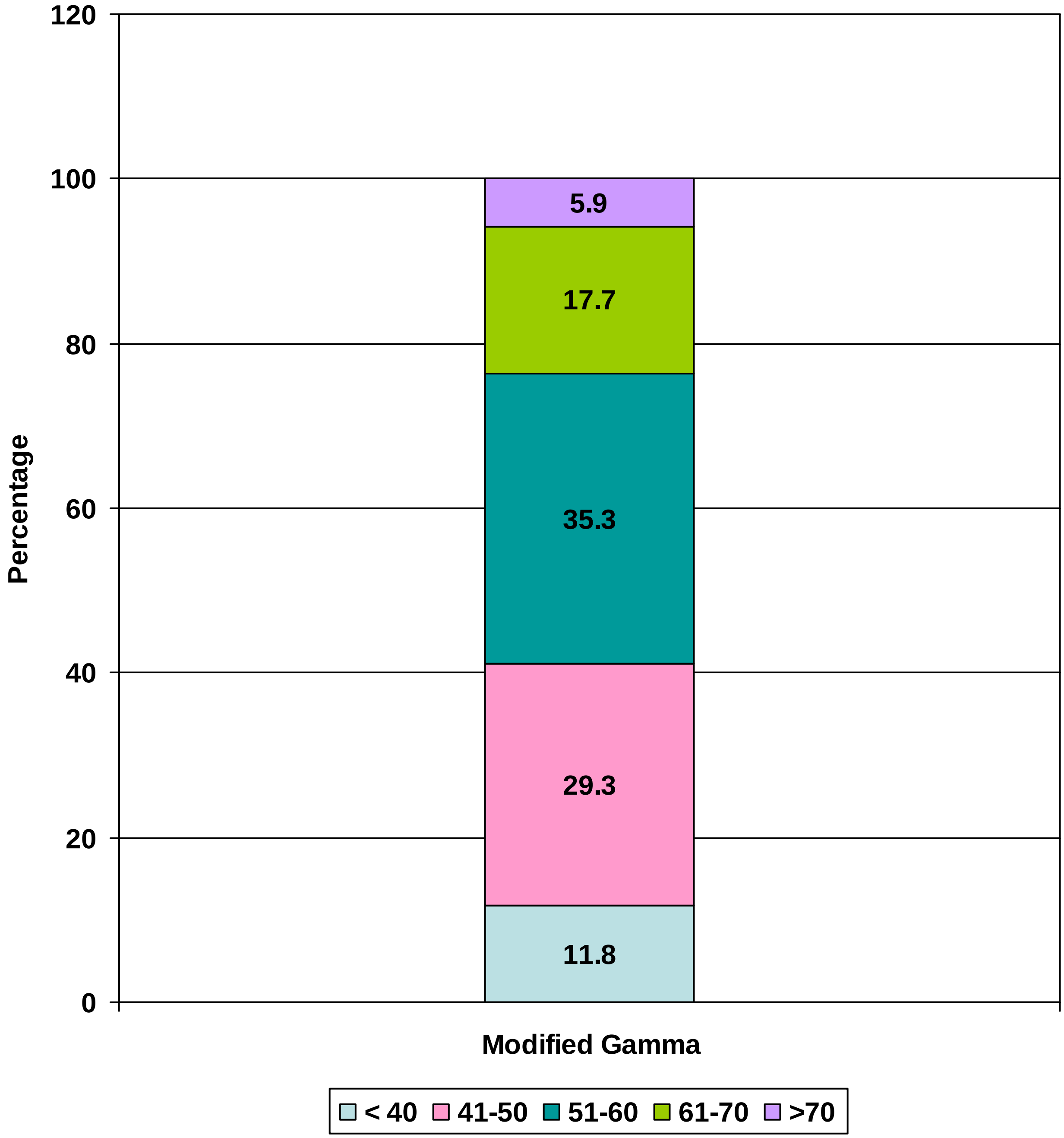
Fracture union (in weeks)

Time (in weeks)	Nail MG Group	
	No	**%**
$\leq$ 10	1	5.8
10 – 15	14	82.4
15 – 20	2	11.8
Mean	12.5	

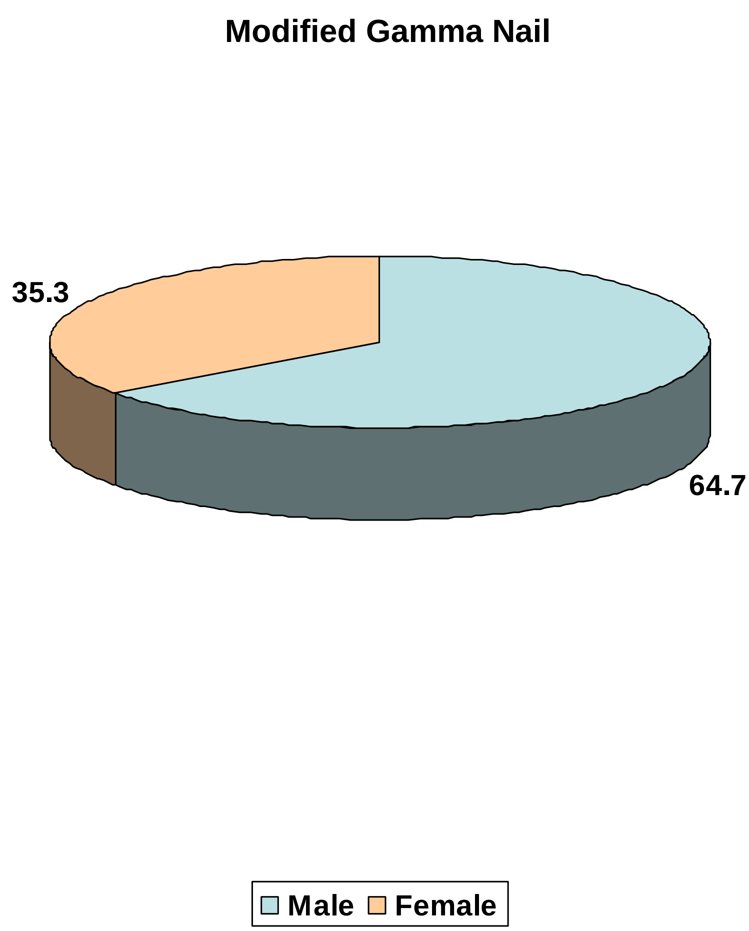
Operating time

Operating time (min)	**Modified Gamma Nail**	
	No	**%**
$\leq$ 60 min	3	17.6
61 - 75	8	47.1
76 - 90	6	35.3
91 - 105	-	-
> 105	-	-
Mean	70.41	
S.D	9.19	

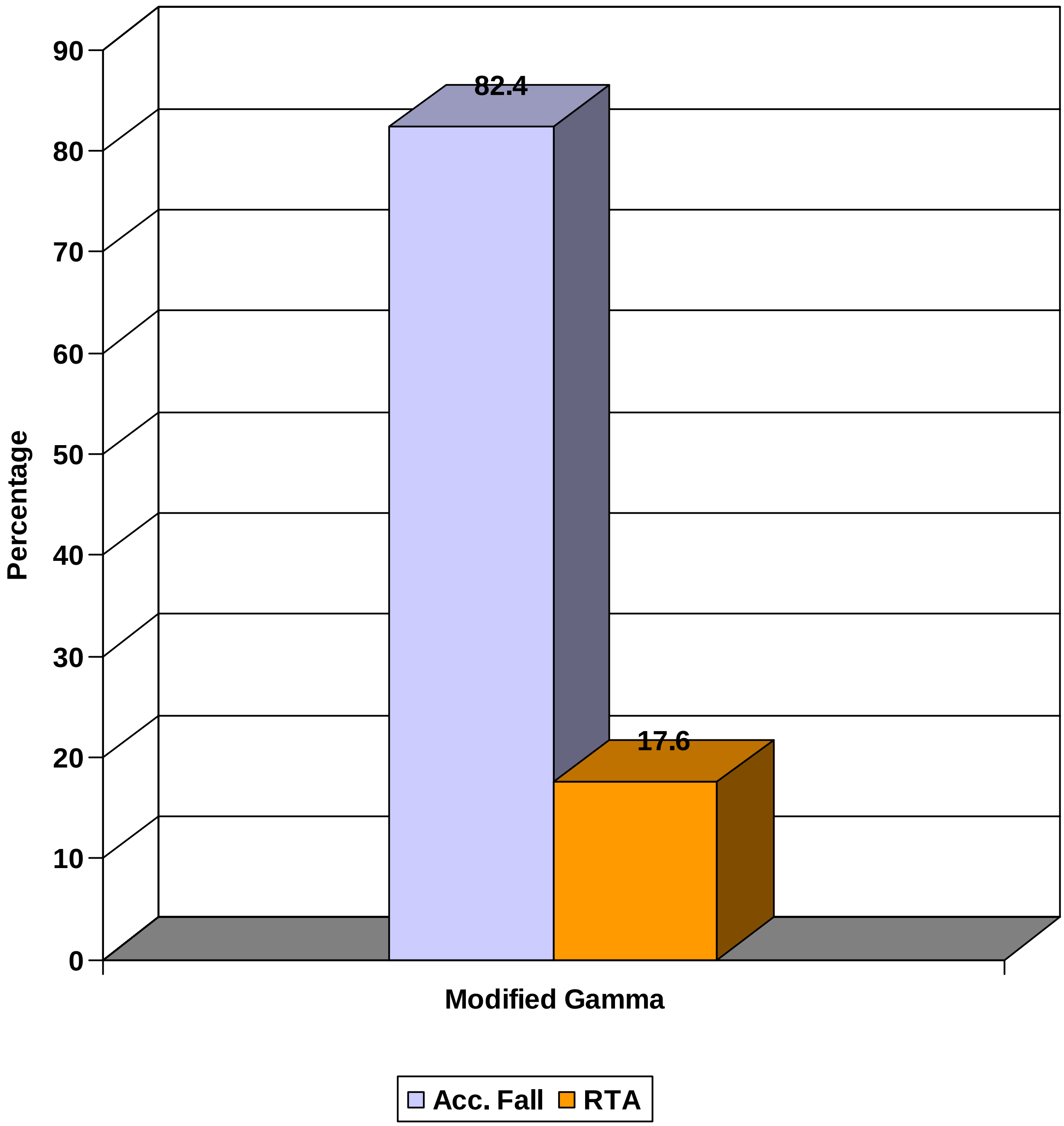
Age (in years)


120
100
80
60
40
20
0
Percentage
5.9
17.7
35.3
29.3
11.8
Modified Gamma
< 40
41-50
51-60
61-70
>70

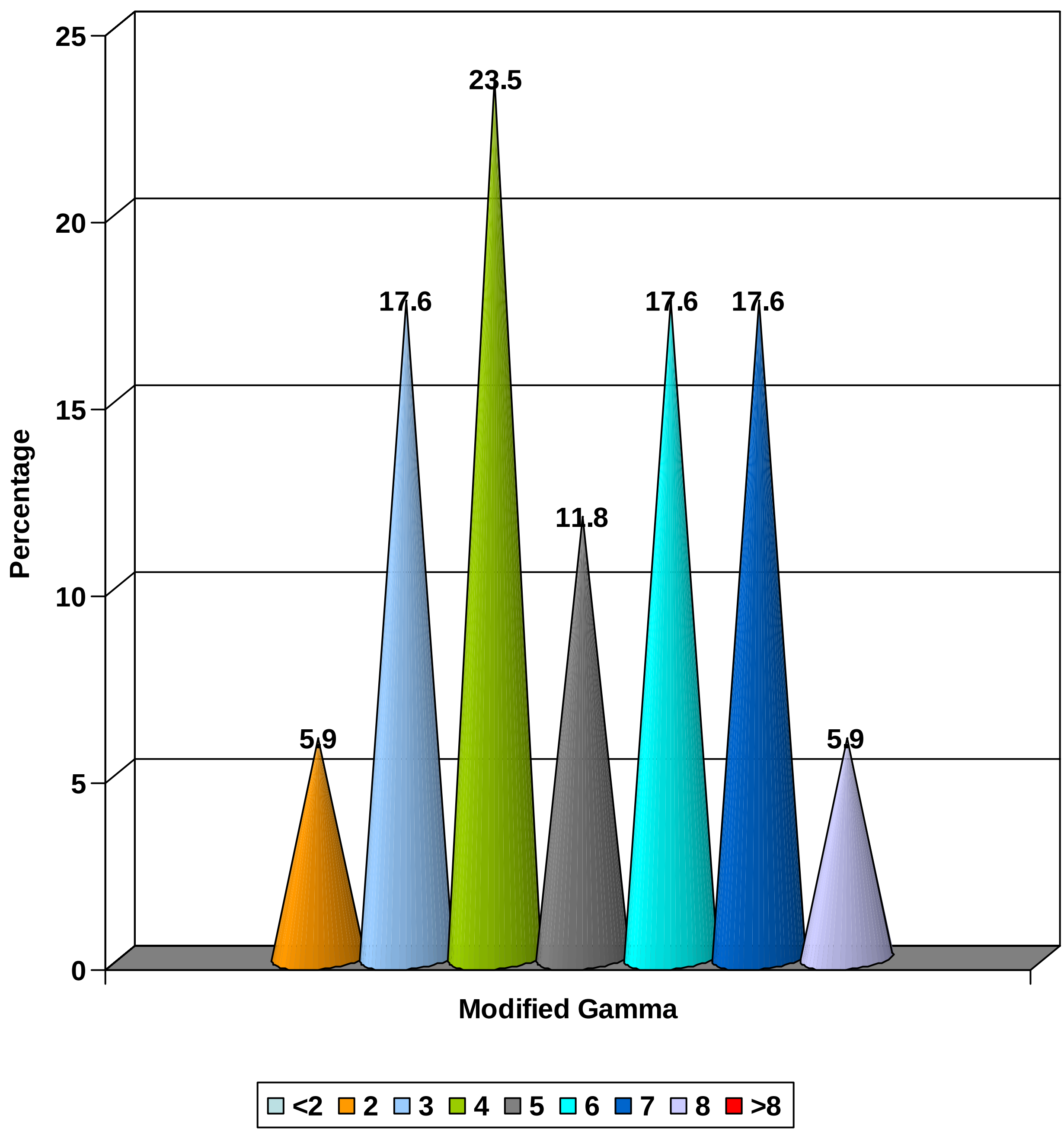
Sex



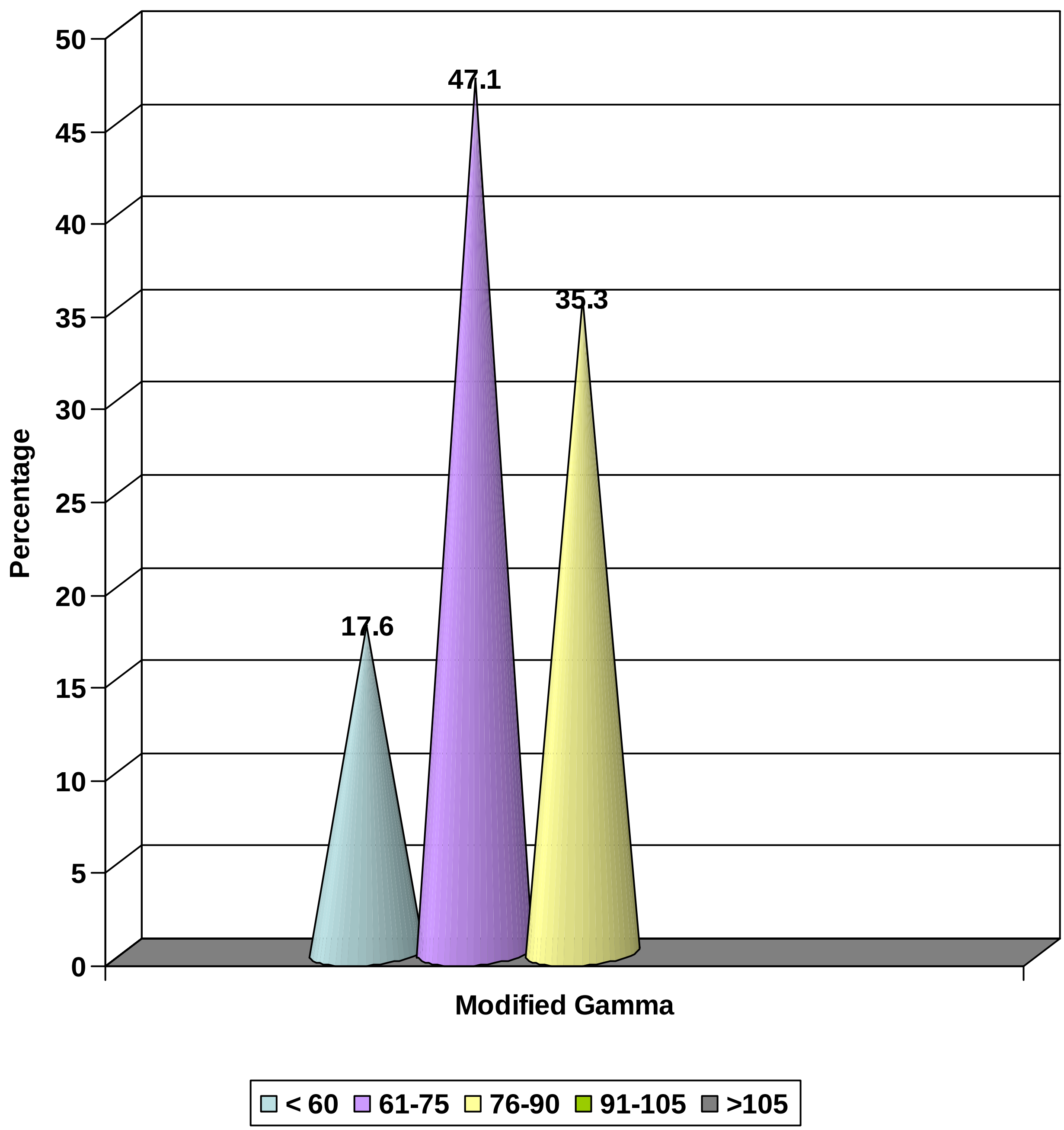
Mode of Injury

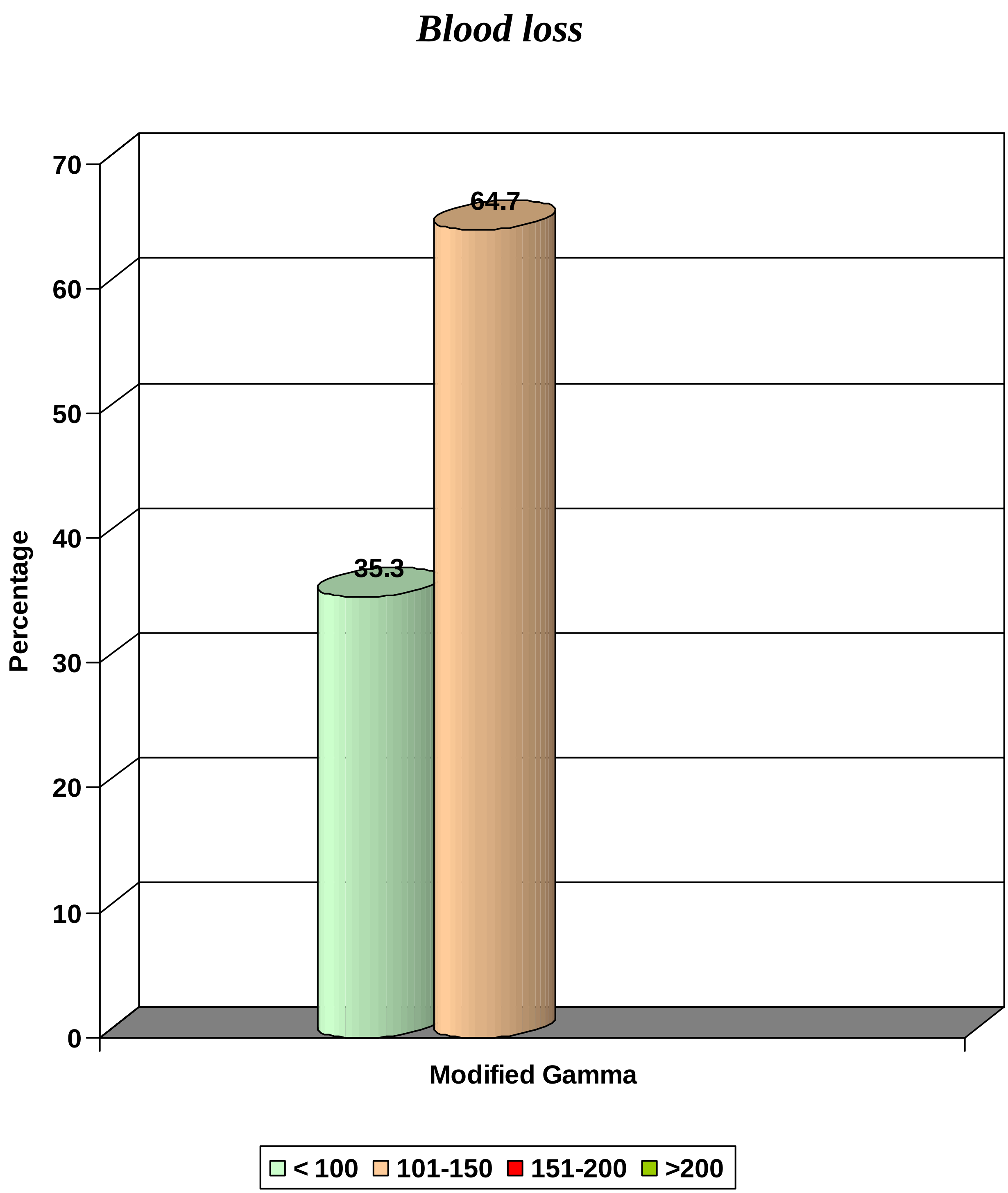


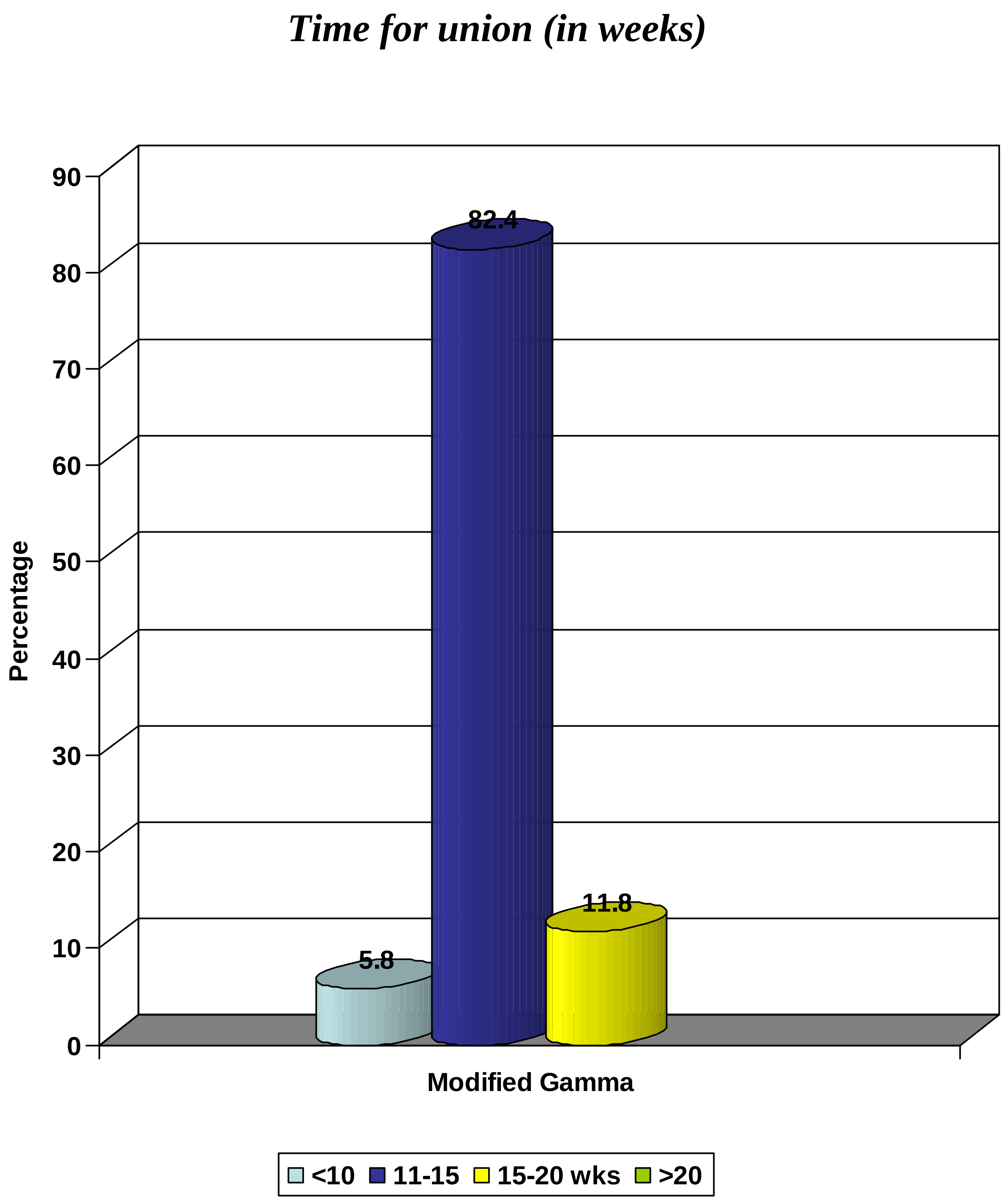
Interval between injury and surgery (in days)



Operating time (in minutes)




Blood loss
Percentage
70
60
50
40
30
20
10
0
64.7
35.3
Modified Gamma
< 100
101-150
151-200
>200



Time for union (in weeks)
90
80
70
60
50
40
30
20
10
0
Percentage
82.4
11.8
5.8
Modified Gamma
<10
11-15
15-20 wks
>20

MASTER CHART

S.No	Name	Age	Sex	IP.No	Mode of Injury	Classification	Side	Associated Injury	Interval Between Injury and Surgery	Reduction Open/Closed	Nail size	Operating time (mins)	Blood loss (ml)	Fluoroscopic exposures (sec)	Complications	Time for union (Weeks)	Harris hip score		Followup in months
																	3 mon	6 mon	
MODIFIED GAMMA NAIL																			
1	Gandhi	52	M	345216	Acc fall	II	R		3	closed	9	82	125	67	Abductor lurch	12	77	84	12
2	Muthalagu	65	M	345214	Acc fall	II	L		4	closed	11	68	100	74		12	83	87	12
3	Mahendran	48	M	354278	RTA	III	L	# BB FA	3	open	9	54	150	157		12	82	90	16
4	Uthrandathevar	70	M	368714	Acc fall	II	R		7	closed	11	73	100	132		9	70	81	12
5	Vadivel	58	M	348962	Acc fall	II	R		4	closed	10	80	125	146		12	85	92	20
6	Veeraiah	72	M	375498	Acc fall	II	L		5	closed	11	63	100	98		12	87	91	16
7	Veeraiah	49	M	345167	RTA	II	R		6	closed	9	75	150	179		12	83	90	20
8	Muthalagu	60	M	324568	Acc fall	III	L		8	closed	11	82	125	87	Abductor lurch	16	73	81	20
9	Pandiammal	51	F	385691	Acc fall	II	L	Pilon#	4	closed	9	56	100	132		12	81	90	20
10	Ramuthai	59	F	324867	Acc fall	II	R		3	closed	9	63	125	91	Varus deformity	12	78	85	16
11	Ramar	35	M	348652	Acc fall	IV	R		2	closed	11	79	150	124		12	86	90	20
12	Krishnaveni	49	F	353469	Acc fall	II	R		4	closed	9	81	125	153		12	71	80	16
13	Sivakami	35	F	316458	RTA	IV	L		7	closed	10	67	100	109		12	76	83	20
14	Balamani	49	F	398741	Acc fall	II	L		6	closed	9	60	150	137		19	83	87	20
15	Irulappan	54	M	352467	Acc fall	II	L		5	closed	10	77	125	161		12	84	83	20
16	Subbammal	48	F	315474	Acc fall	II	R		6	closed	9	71	100	79		12	76	80	20
17	Mariappan	65	M	319846	Acc fall	IV	R	#Shft of humerus	7	closed	10	66	125	83	Abductor lurch	12	72	78	20
		54.1										**70.4**	**122**	**118**		**12.4706**	**79.235**	**85.412**	**17.64706**

MASTER CHART

DHS GROUP

1	Palaniyandi	58	M	335484	Acc fall	II	R		4	open		92	200	17		91			6
2	Guruvammal	54	F	354724	Acc fall	II	L		5	closed		113	225	15	Varus deformity	82			14
3	Songalingam	62	M	365417	Acc fall	III	R		6	closed		111	200	18		100			7
4	Balasubramaniyan	51	M	365487	RTA	ii	L		7	open		97	175	11	Varus deformity	98			9
5	Rakku	45	F	349575	Acc fall	IV	R		3	closed		108	225	23	Lagscrew cutout	79			15
6	Aabatharanagurukkal	52	M	365472	Acc fall	II	L		2	closed		115	200	14		87			13
7	Jeyaram	60	M	328759	Acc fall	II	R		3	open		100	175	17	Varus deformity	93			8
8	Mariaraj	61	M	365471	RTA	III	R		5	closed		96	200	13		109			10
9	A.S.Andisamy	53	M	357482	Acc fall	II	L	#BB forerm	3	closed		109	175	12		74			12
10	Mutharasi	52	F	365417	Acc fall	II	R		2	closed		103	225	21		87			11
11	Ottchu	58	M	317552	Acc fall	II	L		3	closed		99	175	14	Lagscrew cutout	98			16
12	Kannan	61	M	368941	Acc fall	II	R		5	closed		94	200	15		83			18

MASTER CHART

		55.6										**103**	**198**	**15.8**		90.0833			11.58333